linear actuators 35 and 36 are positioned accurately relative to the rotating saw blades and parallel to each other.

Refer now to Figure 8 showing an isometric drawing of the singulation saw 8 showing the counter-rotating saw blades and a Y-axis positioning drive for the saw and the support gantry for the working head that supports the dual spindle saws. The linear actuators 35 and 36 are shown supporting their carrier supports 37 and 38 mounted on mounting and alignment blocks 41 which fit into the recesses 27 of the base or support 26 for the saw 8. It will be noted that the substrate carriers 42 and 43 at the top of the carrier supports 37 and 38 are adapted to receive rectangular substrate strips and are provided with a vacuum source V which extends below the substrate (not shown) and that the substrate carriers 42 and 43 are accurately positionable from one position shown to an orthogonal position 90 degrees from that shown so that the substrate carriers may pass each other during operation of the transport system. The novel system includes a vision system comprising a vision system camera 44 mounted on a Y-axis linear actuator 45 comprising a Y-axis motor 46. The Y-axis actuator is moveably mounted on an X-axis linear actuator which is fixedly mounted on a mounting bracket 48 which mounts on the base or support 26. It will be understood that the camera 44 may be accurately positioned in X and Y over a substrate carried by one of the substrate carriers 42 or 43 in either of their orthogonal positions when at the leftmost vision station end under the vision camera system position as shown at substrate carrier 42. Camera 44 may be mounted over station 3.

Refer now to both Figures 8 and 9 showing the singulation saw 8 which is supported by the base or support 26

ABSTRACT OF THE DISCLOSURE

A bidirectional singulation saw for sawing either substrates or wafers there is provided a pair of counter-rotating saw blades mounted for independent movement in a vertical direction for alternately engaging with a first substrate to be singulated. A transport system comprising a pair of parallel substrate carriers reciprocates a first substrate under the pair of saw blades as alternate ones of the saw blades are engaged to cut the substrate in two X-axis directions. While the first substrate is being cut, the second or other substrate carrier sequentially unloads a cut substrate, loads a new uncut substrate and then moves the uncut substrate to a vision system for determining the position of the substrate relative to the second carrier. The positioned second carrier and its substrate are now in a standby position ready to be cut by the pair of saw blades that are cutting the first substrate.

1 (Amended). A bi-directional cutting saw of the type for use in singulation of substrates and dicing of wafers, comprising:

first and second linear transport means arranged side by side parallel to each other;

each said transport means comprising a linear actuator and a carrier support moveable by said linear actuator;

means for positioning each said carrier support sequentially from a load/unload station to a vision position station and then to a singulation cutting station;

each said carrier support being reciprocally moveable back and forth in an X-axis direction at said singulation/cutting station;

singulation/cutting means for separating semiconductor type substrates/wafer devices one from another while they are mounted on said carrier support by cutting the substrate/wafer as it moves in both X-axis directions; and

simultaneously cutting a first substrate/wafer on a first carrier support on a first linear transport means while simultaneously loading and positioning a second substrate/wafer on a second carrier support ready for cutting on the second linear transport means, thereby reducing lost cutting time to a minimum.

17 (Amended). A system for singulating substrates or wafers, comprising:

a first moveable substrate carrier mounted on a first linear actuator,

a second moveable substrate carrier mounted behind said first linear actuator on a second linear actuator,

means for independently controlling the X, Z and theta motion of each of said substrate carriers,

means for independently controlling the X-position of said substrate carrier on its linear actuator,

said means for controlling the X-position of said substrate carriers comprising means for reciprocally moving one of said substrate carriers in a cutting station under a pair of counter rotating saw blades mounted in the same cutting plane, and

simultaneously positioning the other of said substrate carriers at an unload and loading station, then to a vision positioning station and then to a position outside of said cutting station ready to enter the cutting station when the substrate carrier in the cutting station moves out of the cutting station, thereby virtually eliminating any loss of cutting time.